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UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH ADMINISTRATION
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
DIVISION OF CEREAL AND FORAGE INSECT INVESTIGATIONS
EUROPEAN CORN BORER INVESTIGATIONS
WORK PROJECT I-e-3

and

IOWA AGRICULTURAL EXPERIMENT STATION
DEPARTMENTS OF AGRONOMY
ENGINEERING, HORTICULTURE, ZOOLOGY AND ENTOMOLOGY

COOPERATIVE PROGRAM FOR CALENDAR YEAR 1951

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U. S. DEPARTMENT OF AGRICULTURE

LIST OF PRINCIPAL COOPERATING AGENCIES.

California:
- California Institute of Technology. (Translocation Studies)
- University of California (Insect Diseases)
- Agricultural Experiment Station (Distribution Records)

Connecticut:
- Agricultural Experiment Station. (Surveys)(Parasite Field Status)

Delaware:
- Agricultural Experiment Station. (Surveys)(Parasite Field Status)

Illinois:
- Illinois Natural History Survey. (Surveys, Parasite Colonization and Field Status)(Resistance Investigations)
- Agricultural Experiment Station. (Surveys)(Resistance Investigations)

Indiana:
- State Department of Conservation. (Surveys)
- Purdue Agricultural Experiment Station. (Resistance Investigations, Parasite Colonization and Field Status, and Surveys)

Iowa:
- Agricultural Experiment Station. (All research)
- State Department of Agriculture. (Parasite Colonization and Field Status) (Surveys)

Kansas:
- Entomological Commission. (Surveys)
- Agricultural Experiment Station (Parasite Colonization and Field Status)(Resistance Investigations)

Kentucky:
- Agricultural Experiment Station. (Surveys, Parasite Colonization and Field Status)

Maine:
- State Department of Agriculture. (Surveys)
- Agricultural Experiment Station. (Parasite Field Status)

Maryland:
- State Department of Agriculture. (Surveys, Parasite Colonization and Field Status)
- Agricultural Experiment Station. (Surveys, Parasite Colonization and Field Status)

Massachusetts:
- Agricultural Experiment Station, Amherst. (Surveys)

Michigan:
- Agricultural Extension Service. (Parasite Field Status) (Surveys)
- Agricultural Experiment Station. (Resistance Investigations)

Minnesota:
State Department of Agriculture. (Surveys, Distribution Records) (Parasite Colonization and Field Status)
Agricultural Experiment Station. (Parasite Colonization, Parasite Field Status, Resistance Investigations)

Missouri:
State Department of Agriculture. (Surveys)
Agricultural Experiment Station. (Surveys, Parasite Colonization and Field Status)(Resistance Investigations)

Nebraska:
Agricultural Experiment Station. (Parasite Colonization and Field Status)(Resistance Investigations)
Agricultural Extension Service. (Surveys)

New Hampshire:
State Department of Agriculture. (Parasite Colonization and Field Status)
Agricultural Experiment Stations. (Surveys)

New Jersey:
State Department of Agriculture. (Surveys, Parasite Field Status)

New York:
State Department of Agriculture. (Surveys, Parasite Field Status)
Agricultural Experiment Station, Geneva. (Surveys, Parasite Field Status)

North Carolina:
State Department of Agriculture. (Surveys)
Agricultural Experiment Station.(Parasite Field Status)

North Dakota:
Agricultural Experiment Station. (Surveys, Parasite Colonization and Field Status)

Ohio:
Agricultural Experiment Station. (Surveys, Resistance Investigations) (Parasite Field Status)

Pennsylvania:
Agricultural Extension Service. (Parasite Field Status) (Surveys)
State Department of Agriculture. (Surveys)

Rhode Island:
Department of Agriculture and Conservation. (Surveys)(Parasite Field Status)

South Dakota:
Agricultural Experiment Station. (Surveys, Parasite Colonization and Field Status)

Tennessee:
State Department of Agriculture. (Surveys)(Parasite Field Status)

Texas:
Agricultural Experiment Station. (Distribution Records)

U. S. Bureau of Plant Industry, Soils, and Agricultural Engineering. (Resistance Investigations, Insecticide Application Equipment)

U. S. Bureau of Entomology and Plant Quarantine, Division of Insecticide Investigations. (Insecticide Investigations)

U. S. Bureau of Entomology and Plant Quarantine, Division of Foreign Parasite Introduction. (Parasite Colonization)

Vermont:
State Department of Agriculture. (Surveys)

Virginia:
Virginia Truck Experiment Station. (Surveys, Parasite Colonization and Field Status)
State Department of Agriculture. (Parasite Field Status)
Agricultural Experiment Station. (Parasite Field Status, Surveys)

West Virginia:
State Department of Agriculture and Agricultural Experiment Station. (Survey, Parasite Colonization and Field Status)

Wisconsin:
State Department of Agriculture. (Survey, Parasite Colonization and Field Status)
Agricultural Experiment Station. (Parasite Colonization and Field Status)(Resistance Investigations)

The Agricultural Experiment Stations of a number of States contributed lines of corn for resistance testing.

RESISTANCE INVESTIGATIONS
Ankeny, Iowa and Toledo, Ohio

UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Entomology and Plant Quarantine

Line Project I-e-3-1	Resistant varieties of field corn
Line Project I-e-3-2	Resistant varieties of sweet corn
Line Project I-e-3-3	Factors responsible for resistance
Line Project I-e-3-4	Egg production for use in variety tests

F. F. Dicke and W. D. Guthrie, Ankeny, Iowa
C. A. Crooks, Toledo, Ohio

Bureau of Plant Industry, Soils, and Agricultural Engineering

Work Project d-1-2	Corn Production, Breeding, Disease and Quality Investigations

G. F. Sprague, Lowell Penny and P. A. Miller

IOWA AGRICULTURAL EXPERIMENT STATION

W. S. Haber, Dept. of Horticulture
J. C. Eldridge, Dept. of Agronomy

State Agricultural Experiment Stations
Cooperating

PROGRAM FOR CALENDAR YEAR 1951.

INVESTIGATIONS AT ANKENY, IOWA

(F. F. Dicke and W. D. Guthrie of the Bureau of Entomology and Plant Quarantine, and G. F. Sprague and Lowell Penny of the Bureau of Plant Industry, Soils, and Agricultural Engineering)

Field Corn Resistance

R-1 Promising Experimental Inbred Extractions from Single and 3-way Crosses.

Purpose: To further test and select among the cultures retained from the testing and breeding program conducted at Ankeny, Iowa.

Procedure: Under an infestation supplemented uniformly by artificial infestation in an early planting, simulating first brood attack, to rate and make further selections of low infestation plants. A total of 404 F_2 and F_3 cultures including WF9, M14, Oh45 and W22 as standards for comparison make up this group.

R-2 Testing and Selecting Among Ear Cultures Originating from Two Minnesota Synthetic Varieties and Sprague's #1 Synthetic Variety.

Purpose: To continue selection of low infestation plants in ear cultures retained in the 1950 planting.

Procedure: In 1950 S_1 populations of Sprague's #1 synthetic and 2 synthetic varieties produced at the Minnesota Agricultural Experiment Station were planted and artificially infested at Ankeny, Iowa. Low infestation plants were selfed. A total of 174 selections of the Sprague Synthetic and 108 of the Minnesota Synthetics will be planted at Ankeny, Iowa, for further selection simulating first brood infestation.

R-3 Tests of Early Generation Inbred Cultures Originating from Synthetic and Open Pollinated Varieties.

Purpose: To test and make selections under an infestation simulating attack of the first brood in segregating plant populations.

Procedure: Ear-to-row plots of approximately 25 plants of S_1, S_2 or S_3 cultures will be artificially infested and visually rated on the degree of leaf feeding. Selections will be made in promising plots for selfing. The data including other agronomic characteristics will be as complete as possible. The material consists of the following: 29 S_1 or S_2 cultures of a "stiff stalk" synthetic; 144 S_1 or S_2 cultures of a "low ear" synthetic; 14 F_3 cultures of an early synthetic; 25 S_2 or S_3 cultures of Reids Yellow dent; 62 S_2 or S_3 cultures of the variety Alph; 82 S_1 cultures of a Lancaster composite; 260 S_1 cultures originating from the varieties Midland and Blackhawk and the Crow "Deep Root" hybrid.

R-4 Extraction from Lines from Single Crosses Involving Maize Amargo 2504B and Congo 1365.

Purpose: To transfer the resistance found in Amargo 2504B and Congo 1365 to the plant breeders 32 single crosses to some old line agronomic lines either through back crossing or direct extraction.

Procedure: Evaluate corn borer resistance in populations of the F_2 selfs and select low infestation plants for back crossing and selfing. This group is comprised of 92 ear cultures.

R-5 Tests of Miscellaneous Experimental Inbred Lines Originating from State and Federal Agencies.

Purpose: The objective of tests of miscellaneous items of diverse origin is to screen out lines in initial small test plots. The most promising entries are given further tests in the following year.

Procedure: The number of lines falling in this group total about 450. It is planned to manually apply eggs to simulate the first brood infestation and rely on natural infestation if present for observations on the second brood. A special planting of the most promising lines in this group will be made early in June for observing reaction to natural second brood infestation.

R-6 Open Pollinated Selections in Sprague's #1 Corn Borer Synthetic and the Variety Hayes Golden.

Purpose: To test and make selections in low infestation cultures which have had previous selection in an open pollinated condition under which the high infestation plants were dissected.

Procedure: Evaluate entries under first brood natural infestation supplemented by artificial infestation. Samples of 138 ears are available and will be planted in single plots (25 Plants).

R-7 Open pollinate and Sibbed Selections of Corn of Foreign Origin.

Purpose: To explore varieties of foreign origin for sources of high resistance to the European Corn Borer.

Procedure: Samples of available varieties or their F_2 progenies will be tested in single-row plots and hand infested in the whorl stage. The materials will be evaluated on the basis of leaf feeding and stalk damage. Plants showing little or no evidence of borer infestation will be selected for selfing or sibbing for further tests. The material under test in 1951 consists of 90 sibbed selections from the nursery of Max Hoover which during 1949 and 1950 showed a low rate of infestation. This group will be tested at Ankeny, Iowa. Approximately 50 new introductions will be available for testing in Max Hoover's nursery at Ames, Iowa.

R-8 Early Southern Uniform Single Cross Comparison and Experimental Hybrids from Missouri and Kansas.

Purpose: To test rate single and double cross combinations and supply information to the contributors.

Procedure: Under natural infestation, supplemented by artificial, test the entries in replicated plots. The maturities represented in this material are suitable for the southern part of the North Central Region. It is planned to plant these hybrids early in order to approximate long season development.

R-9 Tests of Experimental Hybrids Originating from Experiment Stations of the Central Region for Relative Resistance and Tolerance.

Purpose: To test and compare new experimental hybrids which are being proposed for regional approval as "AES" hybrids in the Central Corn Belt with several known to have good resistance. AES has been adopted as a symbol for such hybrids.

Procedure: To artificially infest, simulating first brood attack, in replicated plots and to make comparisons by means of visual ratings on leaf and sheath feedings. Records on tolerance including stalk breakage and other agronomic qualities will be taken at or near maturity.

Dissections will be made in several entries including extremes in susceptible and resistant hybrids to determine the relative populations of surviving larvae. Approximately 50 entries will be tested in this group.

R-10 Sweet Corn Resistance

Purpose: To find sources of high resistance to the survival of European corn borer larvae. Transferring resistance factors from known resistant lines; to develop more highly resistant new lines from crosses among known resistant lines (intensification); to develop synthetics from known resistant lines for breeding lines of high resistance; to evaluate breeder's lines for their information and as possible sources of high resistance.

Procedure: Entries will be tested directly in the nursery plots, where a sample at one end of the plots will be artificially infested. All entries will be evaluated for relative degree of leaf feeding and ear infestation.

Nursery plots of W. A. Huelsen, Illinois Agricultural Experiment Station, Urbana, Illinois, will have available inbred entries of Bantam, Country Gentleman, and Evergreen sweet corn lines. The material will include the lines found promising in the 1950 tests. The work on sweet corn resistance in Iowa in 1951 will be carried on in the nursery plots of E. S. Haber of the Department of Horticulture of Iowa State College.

R-11 Popcorn Resistance.

Purpose: To find sources of germ plasm in corn for high resistance to the survival of larvae and tolerance to the European corn borer and to evaluate the borer reaction of lines for the information of the breeder.

Procedure: A sample of 5 plants of each entry will be artificially infested in the whorl stage with 4 egg masses per plant. The entries will be evaluated for relative degree of leaf feeding and stalk breakage. Observations on second brood reactions will be made if an infestation develops.

The work will be carried out in the nursery planting of J. C. Eldredge of the Iowa Agricultural Experiment Station and in a special planting at the Illinois Agricultural Experiment Station in cooperation with G. C. Decker of the Illinois Natural History Survey and W. L. Weaver of Department of Horticulture of the Illinois Agricultural Experiment Station.

Factors Responsible for Resistance

R-12 Studies of Rates of Larval Development and Pupation on a Group of Inbred Lines and Hybrids.

Purpose: To obtain information on the biology of the borer in relation to the morphological and physiological characteristics of the corn plant as it applies to research on resistance. This information is fundamental for determining where and what breeding efforts should be stressed.

Procedure: A selected group of inbreds and a few hybrids will be planted at Ankeny, Iowa. Plants will be infested with a known number of eggs and larval development and rate of pupation will be determined by dissections. Detailed records will be taken on plant parts attacked by the larvae. It is planned to delay planting to avoid complications of natural infestation in studying the larval habits during the second generation infestation. It is also contemplated to expand our information on the habits and development of larvae during the period of second brood attack.

R-13 Translocation Studies.

Purpose: To test translocation lines and backcrosses in an effort to locate genes associated with resistance. In 1950 there was indication that differences between the normal and paired semi-sterile counter-part approached significance in a few instances.

Procedure: A group of paired backcrosses have been selected and made available by Dr. E. G. Anderson of the California Institute of Technology in which certain chromosomal interchanges are present. The reaction of these interchanges will be tested in a replicated plot set-up under uniform artificially applied infestation simulating the first brood attack. The relative infestation will be made by detailed counts of larval feeding lesions and stalk breakage counts.

R-14 The Chemical Nature of Resistance of Corn to Survival of the European Corn Borer Larvae. (Lowell Penny)

Purpose: Theories concerning the nature of resistance of corn to borer establishment have dealt with both the morphological and the chemical characteristics of the plant. The study begun in 1950 delt primarily with the chemical composition of the plant, specifically with the amounts of sugar and nitrogenous substances and the ratio between them in the section of the leaf blades enclosed within the whorl at the time of larval establishment of the first brood.

Procedure: One experiment is planned for 1950 in an attempt to obtain further information concerning the chemical nature of borer resistance. The test will consist of 14 inbred lines of corn known to differ in relative resistance to the borer planted in 25 plant 8-row plots in three replicates at intermediate dates. Hand infestation with eggs produced in oviposition cages will be used to obtain a high level of infestation. Plant height, stage of maturity, and larval survival will be determined in at least two stages of plant development on each plot. Samples of leaf material for chemical analyses will be taken at each stage.

R-15 Effect of Certain Inbred Lines of Field Corn on the Biology of the Corn Borer.

Purpose: To obtain information on the effect of some commonly used inbred lines, known to yield significant differences in the levels of surviving larvae, on the biology of the insect when reared on the same lines through successive generations.

Procedure: In the preliminary phases of this study it is planned to obtain a stock of larvae originating from naturally laid eggs and from eggs produced in the laboratory and utilized for artificially infesting in the regular resistance testing program. A stock of larvae originating from a second brood infestation in a plot of corn planted late in 1950 is available for progeny rearing and a check. The inbred lines selected for the initial tests are WF9, Hy and L317. The lines are to be grown in large blocks to reduce contamination of the larval stocks to a minimum. It is planned to recover the larvae from each line and return the progeny to the respective lines.

Egg Production.

R-16 Mass Production of Eggs.

Purpose: To provide large numbers of egg masses for manual infestation of corn being tested for borer resistance.

Procedure: Cornstalks heavily infested with larvae are caged in the fall to procure moths in the following season.

INVESTIGATIONS AT TOLEDO, OHIO
(C. A. Crooks)

Resistant Varieties of Field Corn

R-17 Testing of Lines Submitted by State and Federal Agencies.

Purpose: Rating experimental and released lines of field corn for relative resistance.

Procedure: Experimental lines and lines released for use in the production of commercial hybrids originating mostly from the Northern States of the North Central Region will be rated for relative resistance and the information made available to the cooperating agencies. In conjunction with the visual infestation ratings, records on other qualities, including plant maturity, stalk breakage, and overall plant characters will be made at or near harvest time.

R-18 Exploration Among Lines Extracted from Single Crosses of Minnesota Origin.

Purpose: To isolate resistant strains of dent corn for tests in breeding programs.

Procedure: The selection of resistant extractions from the single cross Minnesota families has now been almost concluded. In 1948 the most promising extractions with good agronomic possibilities were given permanent designation numbers and have since been given extensive tests to establish their value in introduction into the Minnesota and other breeding programs. The most promising lines from the standpoint of resistance to survival of larvae of the first brood are now in the F_8 stage of inbreeding and will be continued this season to advance the seed and reduce the number of entries per family by a more severe comparison.

R-19 Development of New Lines from Selections Made in Sprague's #1 Corn Borer Synthetic and in Two Newly Introduced Minnesota Synthetics.

Purpose: To isolate resistant strains from synthetic varieties produced from resistant and tolerant lines.

Procedure: The selection of resistant lines from this source has not been too successful. However, 45 lines have been selfed from the various synthetics and will be planted ear to row the coming season. The S_3 plants with low infestations will be selfed after the plots have been visually rated and are within the range of desired resistance.

R-20 Test of and Selections in Derivatives of a Stiff Stalk Synthetic Produced at the Illinois Agricultural Experiment Station.

Purpose: To test and select lines from the promising extractions of the remaining cultures of this synthetic.

Procedure: A total of 29 entries from the most promising lines extracted from six families will be tested ear to row for selfing in the low infested plants. A duplicate planting will be made at Urbana, Illinois, for observation and selection of other desired characters.

R-21 Test of Lines Selected at Toledo from Open Pollinates and Segregating Lines.

Purpose: To isolate resistant lines from various segregating plant populations.

Procedure: The extraction of promising lines from this material will be continued with only 6 selections remaining. This material has been selfed from 4 to 6 times, and very few extractions were able to meet the levels of good resistance.

R-22 Isolation of Resistant Plants in F_3 Populations Originating from Single and Three-Way Crosses Between Resistant Lines.

Purpose: To isolate individual plants on the basis of low infestation.

Procedure: About 100 selections representing 7 families will be planted ear to row this season. Some of these lines possessed resistance to leaf and sheath feeding, whereas other showed resistance and tolerance to stalk infestation. This material has now been advanced to the F_3 stage of inbreeding, the F_2 selections having been made in rather large plant populations. A drastic reduction in the number of families has been made to agree with the assignment of inbred lines into breeding groups as proposed by the Committee of the Corn Improvement Conference of the North Central Region.

R-23 Test of Cooperative Experimental Hybrids of 300 and 400 Maturity Series.

Purpose: To compare the relative ratings of experimental hybrids in the 300 and 400 series of maturity.

Procedure: This test is sponsored by the Corn Improvement Conference of the North Central Region. The entries will be compared by means of visual infestation on leaf and sheath feeding in replicated plots. Records on tolerance, including stalk breakage and agronomic qualities, will be taken at or near maturity.

R-24 Test of Extracting Resistant Lines from the Ohio Three-Way Hybrid (M14 x A206 x Oh4C.

Purpose: To isolate resistant extractions by selective selfing.

Procedure: To test ear to row the most promising extractions for additional improvement in resistant characters. Thirty selections will be planted from 10 survivors of 61 S_2 ears.

R-25 Test of Survival and Pupation Between the Parents and Promising Extractions of Minnesota-Toledo Single Cross (A344 x L317).

Purpose: To compare the amount of improvement obtained through selective selfing for resistance and other desirable characters.

Procedure: To compare the relative resistance ratings of the parent varieties with 5 inbred extractions in 4 replicated plots. The artificial infestation will be applied with a selected number of uniform egg masses in the mid-whorl stage of growth. At or near the completion of the first brood pupation, samples will be taken and dissection of plants made to determine the survival and amount of pupation present. Population and larval counts will also be made again at harvest time.

R-26 Test of Double and Top Cross Hybrids from Commercial Origin.

Purpose: To compare these entries for resistance and tolerance.

Procedure: These entries will be tested for comparison in 4 replicated plots under an infestation simulating first brood attack. Records on tolerance and agronomic qualities will be taken at or near harvest. There are 23 entries in this group.

R-27 Cooperative Test to Evaluate the Damage Caused by the First and Second Generation of Corn Borers to Dent Corn. In cooperation with E. T. Hibbs, Ohio Agricultural Experiment Station.

Purpose: To measure the amount of damage, or reduction in yield, by first and second generation of borers in an early and late planting of two commonly-grown double cross hybrids.

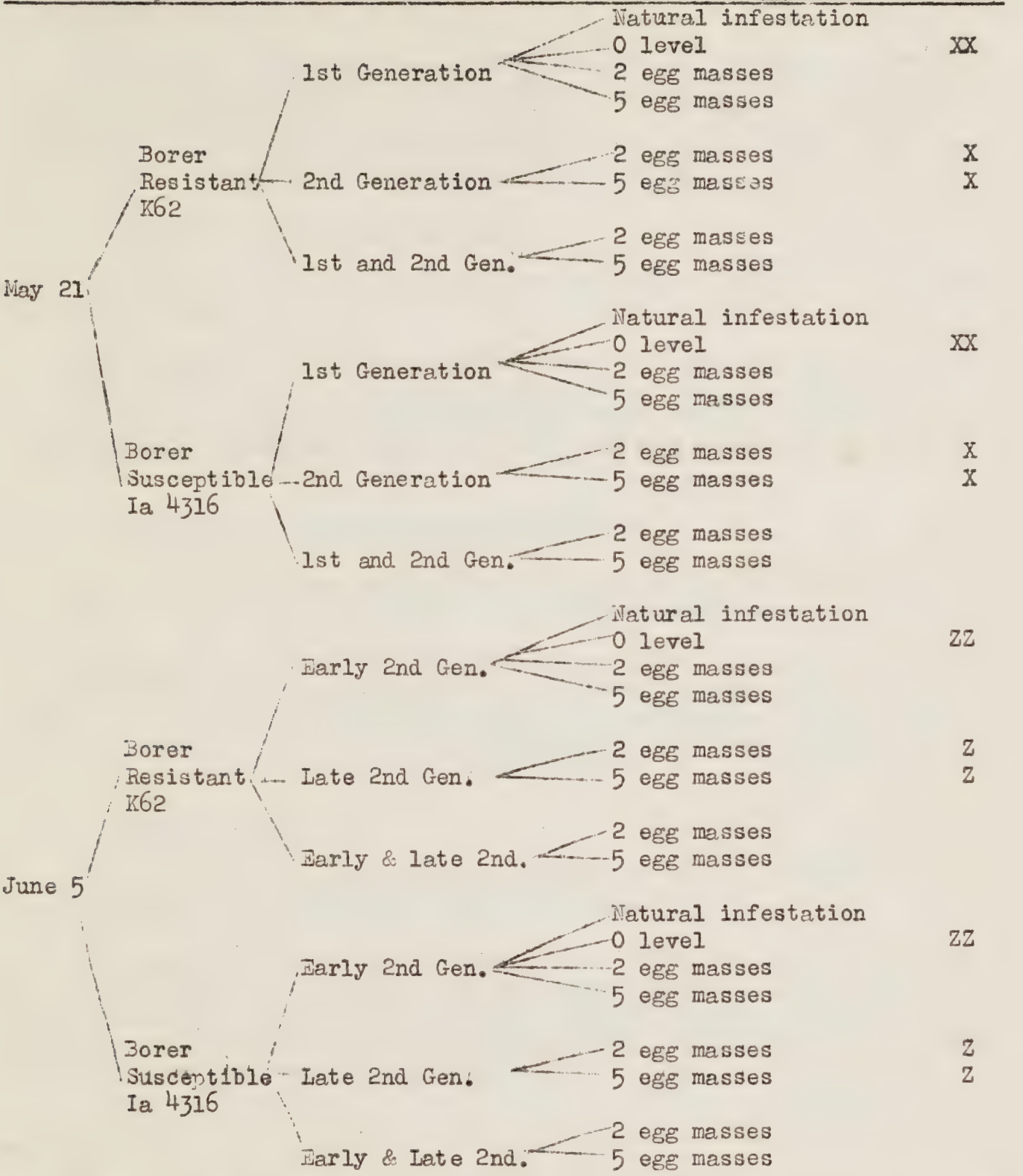
Procedure: The Ohio Experiment Station has planned a cooperative experiment to measure the amount of damage caused by the first and second generation of corn borers to an early and late planting of two commonly-grown double cross hybrids. The hybrids selected have been tested several times, and one has been consistently resistant and the other susceptible to first brood attack.

The following outline shows the various borer levels which will be randomized with the strains in each block and planting date. The levels of infestation will be obtained by the use of artificial infestations in both the first and second generation. The zero level will be obtained by use of an insecticide (Parathion) throughout the oviposition periods.

Population counts will be made to measure the survival of the first generation when the larvae are full-fed or at the end of first brood pupation. The damaging population will be taken approximately 38 days after mid-silk date. The second generation will be estimated in the early fall or at harvest time when the overwintering population will be taken also.

The relationship of plant development and infestation will be recorded and other items as time permits. The number of broken stalks below the ear and other stalk injuries associated with reduction in yield due to borer damage will be taken. Some changes in the above schedules may be necessary to accomodate seasonal variation to both corn and borer development.

Outline of Experiment for Evaluation of Borer Damage - Toledo, Ohio - 1951



* XX Spray plots during natural first and second generation activity.
X " " " " " activity only.
ZZ " " " " second " "
Z " " " " early second generation activity (?)

The treatments and strains will be randomized in replicated 2 x 10 hill plots within planting date blocks (4).

R-28 Cooperative Testing of Sweet and Dent Corn at Lafayette, Indiana.

Purpose: To evaluate relative resistance in sweet and dent corns in breeders nurseries.

Procedure: Pinned egg masses will be sent to Lafayette to artificially infest the most promising sweet corn entries in Mr. Glen Smith's nursery and certain dent corn strains for Dr. A. M. Brunson. Mr. R. T. Everly will supervise these infestations. Some member of the corn borer staff will make the evaluation ratings later in the season.

R-29 Resistant Varieties of Sweet Corn.

Purpose: To rate experimental lines and hybrids developed by State and Federal Agencies.

Procedure: Tests will be made on relative resistance with artificial infestation simulating early summer infestation. Records will be taken primarily on ear infestation in replicated plots as well as other associated developmental plant data. The lines included in these tests are mostly of Wisconsin origin.

R-30 Egg Production for Use in Varietal Tests.

Purpose: To produce large numbers of egg masses for artificial infestation of corn being tested for corn borer resistance.

Procedure: Corn stalks heavily infested with corn borer larvae are caged in the fall to produce moths the following season. The moths are collected, placed in oviposition cages, eggs are laid on waxpaper, cut, pinned, incubated to the blackhead stage, placed on plants to secure a uniform infestation.

R-31 Seasonal Development.

Purpose: To follow the seasonal history of the borer in the West Toledo area in relation to the resistance tests.

Procedure: Observations will be made at periodic intervals to follow the development of the borer in the overwintering populations. These data include pupation, emergence, first oviposition, and hatching dates. The occurrence of second generation development will be followed through dissections within the resistance plots.

INSECTICIDAL INVESTIGATIONS
Ankeny, Iowa

Line Project I-e-3-5	Insecticidal Materials, laboratory tests.
Line Project I-e-3-6	Insecticidal Sprays, field tests. 1/
Line Project I-e-3-7	Insecticidal Dusts, field tests. 1/
Line Project I-e-3-8	Insecticide Application Equipment. 1/

T. A. Brindley, D. D. Questel, and C. C. Blickenstaff
Ankeny, Iowa

Insecticidal Materials, Laboratory Tests.

I-1 Screening of New Compounds in Laboratory at Ankeny, Iowa for Evaluation as Corn Borer Insecticides.

Purpose: To find new materials supplied by the Division of Insecticide Investigations and from other sources, which might be useful as corn borer insecticides.

Procedure: The established, standard laboratory technique will be used in screening these compounds.

I-2 Tests with Systemic Poisons.

Purpose: To learn more about Bis(2-(2-fluoroethoxy)ethoxy)methane, particularly the lasting effects when applied to the soil.

Procedure: Grow wheat and corn plants in soil treated with the above compound and determine the toxic effects of these plants by feeding them to rabbits and also by testing the corn leaves against newly hatched European corn borer larvae using the standard laboratory testing technique.

I-3 Comparison of New Potential Insecticides in Small Field Plot Tests.

Sprays

Purpose: To compare in the field, the insecticidal efficiency of DDT with compounds which have shown high toxicity to corn borer larvae in laboratory tests.

1/ Conducted in cooperation with the Agricultural Engineering Department of Iowa Agricultural Experiment Station and the Bureau of Plant Industry, Soils, and Agricultural Engineering, Division of Farm Machinery, Pest and Plant Disease Control Machinery Laboratory, Toledo, Ohio.

Procedure: Materials found promising in laboratory tests will be sprayed on field corn plants using a gasoline engine powered, wheel barrow sprayer. Plots will be 3 rows wide and 20 feet long and will be randomized and replicated 5 times. Some materials will be tested at more than one dosage rate. Dissections will be made when the borers reach full growth. The following compounds will be applied: EPN-300 1/, DDT, Dilan powder 1/, Ryania 90 percent plus Di-N-propyl maleate isosafrole condensate 9 percent plus wetting agent 1 percent, Ryanocide, Heptachlor, Lindane, Allethrin 1/, Compound 269 1/, E-3770-B, metacide 1/, pentachlorophenol, Niatex, Compound 268, DDT-mineral oil, and Methoxychlor as an emulsion.

Dusts

The same materials, where possible, will be applied as dusts to small plot field tests. Additional multi-purpose dusts will also be tested. Application will be made with a wheel barrow mounted hand duster with a gasoline powered air compressor. Plot layout will be similar to the spray tests or incorporated with them. Dissection of corn plants to determine borer populations will be made when the borers reach full growth.

I-4 Plant Injury caused by Spray or Dust Materials.

Purpose: To determine whether the application of spray or dust treatments causes injury to the corn plants.

Procedure: Observations will be made throughout the season on all spray and dusted plots for injury caused by insecticidal treatment.

I-5 Timing of Insecticidal Applications for First Brood Borer Control.

Purpose: To determine the best time to apply insecticides with relation to oviposition, egg hatching, egg load, corn development, appearance of leaf injury and number of sprays.

Procedure: Single and double applications of both DDT emulsion and wettable powder will be made to early planted field corn at seven day intervals throughout the first brood egg laying and hatching period. The same schedule of treatment will be duplicated on corn planted 10 days after the early corn.

Plots will be 4 rows wide (11.67 feet) and 120 feet long. Each treatment will be replicated four times for each date of planting.

Oviposition and plant development data will be taken regularly on tagged plants. The tagged plants are to be dissected at 7 days intervals to determine the ages of larvae present at the time of spraying.

Larvae counts and yield records are to be taken from the center 40 feet of each plot.

1/ To be applied at more than one dosage rate.

I-6 Night and Day Application of Sprays.

Purpose: To determine whether more effective control can be obtained by applying insecticides to field corn at night over those applied by day.

Procedure: Split plot randomized, block type experimental design will be used. Half of each plot will be sprayed in the daytime and the remaining half at night. Plots will be replicated at least 4 times. DDT dust, 10 percent acid, DDT emulsion, and DDT wettable powder will be compared.

I-7 Comparison of Recommended Treatments.

Purpose: To evaluate more accurately the various recommended formulations and means of application.

Procedure: Select a heavy, natural infested field of field corn and make the follcwing treatments.

1. Ground spray---3 pounds of 50 percent DDT wettable powder in 20 gallons of water per acre.
2. Ground spray--3 quarts of 25 percent DDT emulsion in 4 1/4 gallons of water per acre.
3. Ground dust--20 pounds of 10 percent DDT dust per acre.
4. Airplane spray---3 quarts of 25 percent DDT emulsion in 1 1/4 gallons of water.
5. Airplane dust--20 pounds of 10 percent DDT dust per acre.
6. Ryania dust.
7. Ryania spray.

Plot strips should be replicated at least four times for each treatment.

I-8 Better Synchronization of Parathion Spray Application with Hatching of the Corn Borer Eggs.

Purpose: Because of the rapid loss of parathion residues, it is believed that spray application could be timed so as to provide higher control.

Procedure: Apply parathion spray at 5 day intervals to small plots of field corn from the time the borers begin to hatch until complete hatching has occurred. New plots to receive application on each spray date and no plot to receive more than one application.

I-9 DDT Placement on the Corn Plant.

Purpose: To determine on what portion of the plant newly hatched and half grown borers may be most readily killed by DDT.

Procedure: Applications of a DDT emulsion will be made with a small hand sprayer to restricted parts of the corn plant as follows: the entire plant; whorl area only; entire plant except the whorl; leaves only; leaf axils only. An untreated check will also be used.

Three varieties of corn will be used: Hy x W22 (a resistant variety) WF9 x CI.187-2 (a susceptible variety), and a sweet corn variety (Golden Bantam).

The corn will be planted at a medium date, kept free of natural eggs by hand removal, and artificially infested with from 3 to 5 egg masses in the blackhead stage when the plants are 35 inches in extended height.

Treatments will be applied to one-half of each plot immediately before hand infestation and to the other half of each plot approximately 10 days later after the larvae have become established and are in the third instar.

A randomized split-plot design will be used. Each plot will consist of 6 single plants of each variety spaced 4 feet apart. Each plot will be replicated 6 times.

This experiment will be conducted at Ames by Mr. William Thompson, a graduate student in the Department of Zoology and Entomology.

I-10 Insecticide Residue Studies.

Purpose: The purpose of these experiments is to determine the distribution, quantity, and duration of insecticide residues on corn following their application for corn borer control.

Procedure:

a. Effect of date of spray applications and corn height on residue deposits.

(1) Samples for residue studies on this experiment will be taken from insecticide timing experiment.

(2) Sampling will follow the following pattern for each replicate.

Treatment No.							
1	6/16,	6/23,	6/30			7/21,	8/10
2		6/23,	6/30,	7/7		7/21,	8/10
3			6/30,	7/7,	7/14	7/21,	8/10
4				7/7,	7/14	7/21,	8/10
5					7/14	7/21,	8/10
6						7/21,	8/10
7						7/21,	8/10

(3) Each sample is to consist of a 1 quart aliquot taken from the composite sample of 10 chopped stalks from each of 4 replicates.

b. Relocation of DDT residues on corn plants.

(1) Samples for this study will be taken from treatments made on day and night experiment.

(2) Samples will be taken immediately after treatment and 1, 2, 4, 8, and 16 days following treatment.

(3) Samples will consist of 5 plants from each replicate dissected into whorl, leaf tips, leaf bases, and stalks. Entire sample will be sent for analysis.

c. DDT residues resulting from placing DDT on various positions on the plant.

(1) Samples for this study will be taken from the plots treated in the insecticide placement study.

(2) Five plants will be dissected from each treatment into whorl, leaf tips, leaf bases, and stalk immediately after treatment. Five additional plants will be dissected when the larvae reach the 4th instar.

d. Effect of nozzle arrangement, spray volume, and spray pressure on DDT distribution.

(1) Samples for this study will be from single row plots treated to determine the effect of treatments on borer mortality.

(2) Each treatment will be sampled immediately following the applications. Five plants will be dissected into leaf tips, leaf bases, whorl, and stalk from each of six replicates. Similar samples will be taken at harvest to determine duration of deposits.

e. Determination of residue deposits from other insecticides.

(1) Material for analysis will be taken from small plot screening tests.

(2) Four, 10 plant replicates will be taken from each replicate immediately after application and at maturity.

(3) One quart samples will be submitted for analysis.

(4) In the case of volatile materials 2-10 plant aliquots will be taken following treatment and 4 days later.

f. Insecticide residues in or on corn kernels.

(1) Corn samples will be taken from treated plots to determine if there are DDT deposits on or in the kernels of corn.

g. If it seems feasible, after consulting with statisticians, an experiment will be conducted to determine the size of the sample, and the size of the aliquot of the sample to secure the most reliable estimate of insecticide residues.

I-11 Comparison of the Effect of Spray Volume.

Purpose: To determine the relative effectiveness of different spray volumes.

Procedure: DDT emulsion will be applied at the rate of 1 1/2 pounds of DDT per acre in the following spray volumes: 2 1/2, 5, 10, 20, and 80. Two applications will be made to 200 foot single row plots. Each treatment will be replicated six times. Borer control will be determined by dissecting 10 stalks selected at random from each plot. These tests will be made using DDT emulsion on the susceptible field corn hybrid 4297 and duplicated on Iowa Chief sweet corn if time permits.

I-12 Comparison of the Effect of Nozzle.

Purpose: To determine the influence of nozzle arrangement on the effectiveness of DDT sprays.

Procedure: DDT emulsion will be applied at a rate to give 1 1/2 pounds of DDT per acre through the following nozzle arrangements: single hollow cone, single 80° fan, three 65° fans above the row, two 65° fans above the row, two 65° fans in tandem, and two 65° fans lateral and one above row. Two applications will be made to 200 foot single row plots. Each treatment will be replicated six times. Borer control will be determined by dissecting 10 stalks selected at random from each plot.

I-13 Comparison of the Effect of Spray Pressure.

Purpose: To determine the effect of spray pressure on the kill obtained with DDT.

Procedure: DDT emulsion will be applied at the rate of 1 1/2 pounds of DDT per acre in 10 gallons of water at the following spray pressures: 20, 40, 80 and 160. The material will be applied through single 80° fan type nozzles to 200 ft. single row plots. Each treatment will be replicated six times. Two applications will be made. Borer control will be determined by dissecting 10 stalks selected at random from each plot.

I-14 Effect of Formulation on Borer Control.

Purpose: To determine the effect of various types of solvents used in the preparation of DDT emulsion on the kill obtained.

Procedure: DDT emulsions prepared from six different solvents will be compared when applied to field corn at the rate of 1 1/2 pounds of DDT per acre in 5, 10, and 20 gallons of water. The following solvents will be used: petroleum xylene, coal tar xylene, Bronco Hi Sol No. 4A, PD 544C, Velsicol AR 50G, and Velsicol AR 60. The materials will be applied through 80° single fan type nozzles to 200 foot single row plots. Each treatment will be applied twice and will be replicated six times. Borer control will be determined by dissecting 10 stalks selected at random from each plot.

I-15 Effect of Corn Borer Control on the Field of Ensilage.

Purpose: To determine if the control of the corn borer on ensilage corn will increase the tonnage of ensilage.

Procedure: Plots six rows wide will be treated with ryania spray (6# of ryania in 40 gallons of water) and ryania dust (40# of 40% dust). The ensilage obtained from each plot will be weighed to determine if corn borer control increased the tonnage produced. Borer mortality will be determined by dissecting 16 stalks selected at random from each plot. Each material will be replicated as many times as the size of the field permits.

I-16 Borer Resistance to DDT.

Purpose: To determine whether corn borers will develop resistance to DDT when subjected to applications for several successive generations.

Procedure: Gather pupae in August and rear borers continuously in the laboratory. Portions of the larvae of each succeeding generation will be subjected to different DDT dosage levels. A portion of the larvae will be kept free of DDT to serve as a check.

I-17 Timing of Insecticidal Applications for Second Brood Borer Control.

Purpose: To determine the best time to apply DDT with relation oviposition and egg hatching.

Procedure: Apply single applications of DDT emulsion spray to late field corn beginning with first eggs and continuing at 7-day intervals throughout the oviposition and hatching period.

Plots will be the same size as those used in the first brood timing experiment.

ELECTRIC LIGHT TRAPS FOR CONTROL OF THE EUROPEAN CORN BORER--PLANS FOR SEASON OF 1951. Ames, Iowa - Project 504-11 U. S. Dept. of Agriculture In Cooperation with the Iowa Agricultural Experiment Station. J. H. Lilly, D. L. Calderwood, and C. E. Johnson, Ames, Iowa.

I-18 Comparison of Various Types of Traps in Tests on Area Control.

Purpose: To evaluate and compare new types of grid traps and a suction trap.

Procedure: Two single grid traps, two triple grid traps, and two lights with no killing or retaining device will be set up in two replicates in a corn field. A suction light trap and a light with no killing or retaining device will also be set up in this field. Each of the above mentioned fixtures will be located at the center of a square plot in a field of field corn, the plot to measure 300 to 400 feet on a side. Each fixture with the exception of the suction type trap will be equipped with three 30 watt, 360 BL lamps. The following data is to be taken:

(a) Daily counts of the corn borer moths killed or caught by each of the traps.

(b) Periodical egg mass counts at corresponding locations in each of the plots.

(c) Borer population counts at corresponding locations in each of the plots.

(d) Weather information. Wind velocity and temperature on recording instruments.

Test on the Attractiveness of Reflecting Surfaces.

Purpose: To evaluate the effectiveness of reflecting surfaces for attracting corn borer moths.

Procedure: Cyanide traps to test reflecting surfaces will be built. The 14 surfaces to be tested include 12 painted with fluorescent lacquer enamels distributed by Switzer Bros. of Cleveland, one painted with ordinary white enamel, and one of aluminum foil. Each trap will be illuminated by two 15 watt 360 BL fluorescent lamps. The data to be taken is a daily count of the corn borer moths killed by each trap. It will be assumed that the number of corn borer moths killed by each trap is proportional to the attractiveness of the inside surface. All but the four most attractive surfaces will be eliminated during the second brood flight of moths. This will make it possible to have two replicates of each of the four most attractive surfaces during the second brood flight of moths. Because more moths will be found at one location in comparison to another, seven traps will be installed at one location, and seven traps in another location.

Test of the Heat Trap

Purpose: To determine the effectiveness of using heating elements in trapping corn borer moths.

Procedure: Two heat traps will be installed at different locations. With each heat trap will be installed a similar trap without a heating element, but utilizing cyanide for killing moths. A daily count will be made of the corn borer moths killed by each of these four traps.

PARASITE INVESTIGATIONS
Ankeny, Iowa and Moorestown, New Jersey

Line Project I-e-3-9	Parasite Biology
Line Project I-e-3-10	Parasite Colonization
Line Project I-e-3-11	Parasite Field Status

K. D. Arbuthnot, Ankeny, Iowa; D. W. Jones
and S. W. Carter, Moorestown, New Jersey

P-1 Parasite Biology.

Purpose: To add to the general knowledge of the biology of parasites as an aid in planning more efficient releasing techniques for the species and to explain the success or failure of the various species in certain localities.

Procedure: Study the information accumulated from special study localities and from extensive areas to learn the requirements for successful establishment and maintainance of the various species.

Study under controlled conditions the biology of exotic species established in widely separated areas but not generally successful in some extensive areas to learn whether there is evidence of the development of races in the isolated establishments. Evidence of differences would indicate that the survivors in a region where the species was not generally successful might be better adapted to the environment than those from other regions and should be used for intra-regional colonizations. This information is needed, especially on Horogenes punctorius Roman in Eastern States, northwestern Ohio, Benton County, Iowa and LeSueur County, Minnesota, and Macrocentrus gifuensis Ashm., in Eastern States and Bremer County, Iowa.

Study under controlled conditions, parasites from different foreign areas to determine whether there is evidence of racial differences between those from various areas as an aid in explaining different reactions when they are released in America.

Study the biology and seasonal history of parasites and their relation to host biology wherever a species is established. Obviously Bureau personnel are not located advantageously for doing this in many areas, and States are encouraged to make these studies especially as problems for graduate students. This type of information may provide the basis for improved techniques for colonizing parasites, provide explanations for the behavior of the parasites in different regions where they are variably successful and basic information on the effect of parasites on host populations.

P-2 Parasites other than Insect Forms.

Purpose: Identification of biological forms causing borer death, the development of techniques suitable for determining their role in reducing borer populations and possible means of increasing their effectiveness.

Procedure: Submitting to specialists dead borers which may have been killed by disease for identification of the organisms. (Dr. Steinhaus, University of California, has been very helpful and cooperative in this phase of the work). The testing of procedures to provide specimens suitable for diagnosis and the adaptation of them to field survey investigations. Consideration should be given to initiating laboratory and field studies on the use of diseases, indigenous or introduced, for control of the pest.

Parasite Colonization

P-3 Colonization of Exotic Parasite Species.

Purpose: To continue the testing of parasites, including those species established in the United States and other exotic forms which may become available from importations, over additional parts of the corn borer infested area by establishing study points in recently invaded areas especially where different environments prevail. To assist in the distribution of parasites in cooperation with interested states and at their expense.

Procedure: Production of parasites for releases in areas where the various species have not been tested from collections taken where exotic species are established in America and from importations. Maryland is the only state providing funds for extensive releases in 1951 while Kansas and North Dakota provided limited funds for test colonies in these states. Colonization in other states will be confined to releases at study points.

Domestic sources of material providing parasites this year are hibernating corn borer larvae collected; in Connecticut to provide principally Macrocentrus gifuensis and, some Chelonus annulipes Wesm., Horogenes punctorius and Lydella stabulans grisescens R.D., will come from them; in New Jersey to provide L. stabulans grisescens and H. punctorius. Importations from Europe will provide Campoplex alkae Ell. S. Sacht., and Microgaster tibialis Nees., from hibernating cocoons and hibernating corn borer larvae are expected to provide some Apanteles thompsoni Lyle and L. stabulans grisescens.

All rearing will be done at the Moorestown laboratory and shipment of adult parasites will be by air express. Most of the releases will be made by State personnel.

Parasite Field Status

P-4 Summer Survey.

Purpose: To continue a long time study on established parasites in four Eastern study areas located at East Hartford, Connecticut, Taunton, Massachusetts and at Atlantic and Burlington, New Jersey. The continuation of the study started last year in Boone County, Iowa to learn the role of parasites as one of the ecological factors affecting host populations in the Corn Belt.

Procedure: The interactions between species and their relationship to host populations in the area are being studied by the accumulation of data over a long period of years in the Eastern areas. A similar study is in progress (started in the spring of 1950) as part of an ecological study of the host, in Boone County, Iowa where all stages, except eggs, taken in the ecological study will be collected and reared. Lydella stabulans grisescens and Eulophus viridulus were the only exotic species taken here in 1950, accounting for less than one percent of the borers, and neither species has been released in the County. All of these studies are made by taking samples from a polar coordinate arrangement of placement.

P-5 Fall Studies.

Purpose: To provide current information on; establishment, dispersion, abundance and effectiveness of parasites as an aid in controlling the pest. The accumulated information is used in planning future colonization programs, as a guide for advising States interested in extensive colonizing and as a measure of the effectiveness of the parasites.

Procedure: The program for field work will be formulated in consultation with State agencies to obtain the greatest amount of information from the efforts of State and Bureau personnel. The Bureau plans to process all collections which the states can obtain, thus enabling all State effort to be used in making collections. Collections fall into three general categories:

Those taken from special study localities from a uniform pattern of sampling used continuously for several years and these are divisible into two types, one, where parasites are established and two, where parasites are believed not to be present. Boone County, Iowa, is in this category where only a trace of exotic forms was found in 1950 and similar studies are proposed in Waseca County, Minnesota and Smith County, Kansas. (Host population studies are to be made in these counties before exotic parasites become a factor affecting the host and continued after they become a factor).

Those taken at release sites to determine whether or not released parasites became established and if they survived after initial establishment.

Those taken without regard to colonization sites, whether from a regular sampling technique to determine the prevalence of parasites in extensive areas, or, from miscellaneous collecting points wherever they can be taken providing principally information on dispersion.

Line Project I-e-3-12 Seasonal Development
Line Project I-e-3-14 Effect of Climatic Factors, etc.

C. A. Henderson, Bureau of Entomology and Plant Quarantine, Ankeny, Iowa, and D. L. Goleman, Department of Zoology and Entomology, Iowa Agricultural Experiment Station, Ames, Iowa

B-1 Observations at Boone County, Iowa.

Purpose: To obtain basic data on the occurrence development and habits of the European corn borer and their relation to corn growth, farm practices and prevailing weather conditions and to determine the abundance of parasites and predators.

Procedure: Regular observations on the seasonal development of the corn borer will be continued in the Boone County, Iowa, study area. These observations will be confined to Boone County proper and will include 88 corn fields obtained through a restricted random selection procedure which was followed in 1950. Field sampling will be the same as in 1950. Investigations will include the developmental stages of the borer, such as pupation, emergence, oviposition, borer infestation and populations. These data will provide information on seasonal development, population fluctuations, parasites, predators, and related crop and meteorological developments in relation to corn borer control through population reductions.

Line Project I-e-3-13 — Surveys of Abundance, Distribution and Damage

E. W. Beck and L. H. Patch, Ankeny, Iowa

S-1 Abundance Surveys.

Purpose: To determine through formal survey procedures abundance of the European corn borer in the important corn growing regions of the United States to provide information upon the status of the insect in 1951.

Procedure: Active participation in field surveys will be limited to the immediate vicinity of the Ankeny Field Station. Every possible assistance and encouragement will be given cooperating State Agencies making corn borer abundance surveys. Summaries of data supplied by cooperating State Agencies will be assembled in the form of a report on the status of the insect in 1951.

S-2 Distribution.

Purpose: To determine as completely as conditions permit the dispersion and distribution of the European corn borer in the United States.

Procedure: The search for new infestations by the corn borer will be limited to States requesting assistance in making such a search, subject to further limitations due to availability of personnel and funds.

S-3 Determination of Damage to Field Corn.

Purpose: (a) To establish indices of damage caused by borers of first brood and second brood, and infestations of combined broods.

(b) To determine amount of stalk breakage caused by each brood.

(c) To test visual methods of rating plant damage related to numbers of borers as the method applies to the fall survey of abundance.

(d) To obtain, incidentally, information on effect of insecticidal treatment on yield not attributable to induced differences in borer populations.

Procedure: Approximately 25 fields in the vicinity of the Ankeny Field Station, if not available on the field station grounds, ranging from early through late types will be selected for the experiment; replicate plots will be utilized in each field for each treatment.

Procedures will be followed to provide plots in each field infested as follows:

(a) With first brood borers only.

(b) With second brood borers only.

(c) With borers of both broods.

(d) With no infestation.

Yield data and other pertinent information (numbers of borers, visual ratings, etc.) will be taken from each plot. Comparisons will be drawn and relationships studied.

The standard method of inducing different levels of borer population by placing different numbers of laboratory produced egg masses on the plants will be followed.

In this study 6 x 5 hill plots replicated 12 times for each of four plantings of one hybrid will be used. Plantings to be made about May 5, 15, 25, and June 4; the May 5 and 15 plantings to be infested with June eggs and the May 25 and June 4 plantings with August eggs. Rows of 5 hills are to be infested with 0, 2, 4, 8, and 16 egg masses per plant, respectively. The 6th row in each plot will be treated with an insecticide in an attempt to bring the natural infestation as near zero as possible. Thus 450 egg masses are needed in each plot and 5,400 for each planting. Successive samples of plants, one from each row of each plot, to be dissected to count the borers, to estimate the number that caused damage before they begin to disappear from the plants. If three samples are taken, a total of 864 plants would be dissected, leaving 144 plants for yield from each borer level in each planting. The regression of yield on borers should give desired index of damage for each planting.

In addition, data on silking dates, plant breakage, and external evidences of borer infestation will be obtained.

S-4 Estimates of Damage.

Purpose: To estimate loss caused by the insect to field corn in the United States.

Procedures: Dependent upon results of the experiment to determine indices of damage loss estimates will be prepared utilizing fall survey data and current estimates of production.